

EPA Coalbed Methane Outreach Program Technical Options Series

COAL MINE METHANE AND LNG



100 gallon per day prototype Thermoacoustically Driven Orifice Pulse Tube Refrigerator
(Photo courtesy of Cryenco, Incorporated)

PRIMARY BENEFITS OF USING COAL MINE METHANE FOR PRODUCING LNG...

- ◆ Can operate on methane from mine pre-drainage and medium quality gob gas
- ◆ Uses methane at near atmospheric pressure, avoiding compression costs
- ◆ Can use methane diluted with up to 20 percent nitrogen
- ◆ Reduces emissions of methane (a potent greenhouse gas)
- ◆ Highly mobile system can be located near methane collection site

Small-scale LNG units can use coal mine methane from production wells or medium quality gob gas

WHY CONSIDER COAL MINE METHANE FOR LIQUIFIED NATURAL GAS?

As liquified natural gas (LNG) producers compete for growing markets, they are seeking ways to cut production costs. LNG plants have traditionally been large, elaborate, and expensive. Smaller facilities are now becoming economic, creating new opportunities in the form of both non-traditional markets and non-traditional gas sources.

Coal mine methane may prove to be a low-cost alternative to conventional natural gas for LNG production in some areas. Gob areas (collapsed rock over mined-out areas) release large quantities of gas, which mines remove with ventilation fans, sometimes supplemented by drainage systems. Air from mine ventilation contaminates the gob gas, usually making it unsuitable for pipeline injection. However, recovering and using gob gas to make LNG can reduce the amount of methane that mines emit to the atmosphere while producing inexpensive fuel for mine vehicles, machinery, heating, or other local uses.

Traditionally, LNG production has been limited to very large operations located near natural gas pipelines. Small-scale refrigeration techniques have succeeded in efficiently downsizing gas liquefaction units so that they are portable and inexpensive. Instead of compressing gas mechanically, these units use acoustic power to compress and expand a working fluid (normally helium), dissipating heat through exchangers. A linear motor or thermoacoustic driver in a tube generates the acoustic power.

Acoustic LNG compression units are highly portable making them ideal for remote locations

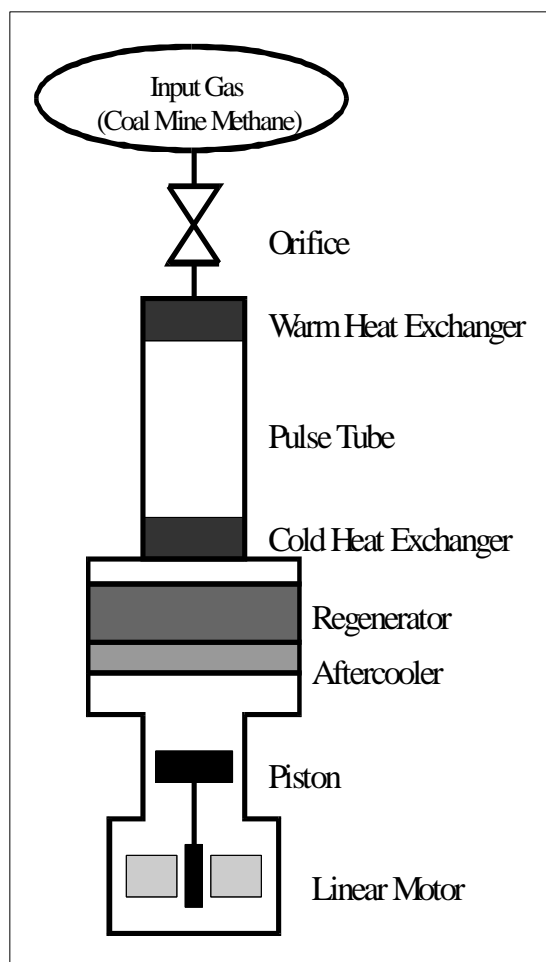
The smallest acoustic liquifaction process is Linear Motor Driven Orifice Pulse Tube Refrigeration. These units are available in a range of sizes, with output ranging from less than 10 gallons of LNG per day to several hundred gallons per day. The units are from 40-400 pounds and one to five cubic feet in volume, depending on the capacity. Linear motor drivers use flexure bearings that have no wearing surfaces, reducing maintenance costs. Efficiencies for these units can reach 85 percent.

Larger, but still portable, is the Thermoacoustically Driven Orifice Pulse Tube Refrigeration unit. Los Alamos National Laboratories and the National Institute of Standards and Technology first developed this technology in 1989. The thermoacoustic process uses a temperature gradient of 1640° F along the length of the unit to generate an acoustic wave. Prototypes have successfully produced 500 gallons of LNG per day at 70 percent efficiency. Cryenco, Incorporated projects that a commercial unit that will produce between 10,000 and 12,000 gallons LNG per day at approximately 80 percent efficiency will be available in 1999.

SOME FACTS ABOUT SMALL SCALE LNG PROCESSES...

- ◆ Some units require as little as 3 thousand cubic feet/day (mcf/d) of medium quality gas to efficiently produce LNG on site
- ◆ 100 scf of methane can produce between 0.7 and 1.0 gal of LNG (59,000-85,000 Btu)
- ◆ Small LNG compression units weigh as little as 40 pounds
- ◆ Gas quality as low as 800 Btu is acceptable
- ◆ Ideal for remote collection sites where pipeline is not available
- ◆ Operate at 70-85 percent efficiency

Mines that produce LNG on site using gob gas can use it to operate mine vehicles and equipment, or may sell to a local consumer



Linear Motor Driven Orifice Pulse Refrigeration Compressor Schematic

CURRENT MARKETS FOR LNG

Worldwide, the largest market for LNG is fuel for electric power plants. The international gas association, Cedigaz, projects that the volume of LNG traded internationally could grow between 80% to 170% by the year 2005. The bulk of this growth is expected to occur in Asia, including nations such as China and India that have abundant coal mine methane resources. As a result, the expanding LNG market in Asia offers opportunities for coal mine gas use.

LNG is becoming increasingly popular as an alternative fuel for vehicles. Vehicles can store more liquid gas than compressed gas, making it well-suited for high fuel consumption vehicles, including underground coal mine vehicles. In addition, substantial federal and state gas tax credits are available in the U.S. for converting and using alternative fuel vehicles.

One emerging use of LNG in North America is for seasonal gas storage. LNG plants, also called peak shaving plants, store natural gas during the warmer months, then vaporize and inject the gas into local pipelines during cold weather months. LNG plants could help the economics of coal mine methane projects in areas where other gas storage options are limited.

COMPARISON OF LNG COMPRESSION TYPES THAT COULD USE COAL MINE METHANE

<i>PARAMETER</i>	<i>CONVENTIONAL PROCESS COMPRESSOR</i>	<i>LINEAR MOTOR DRIVEN</i>	<i>THERMO-ACOUSTICALLY DRIVEN</i>
Typical output capacity (Gallons/day)	500	10-500	500-10,000 ¹
Typical input capacity (Mcf/d)	60-70	1-50	50-1,200
Typical dimensions (cubic feet)	100	1-5	4,000
Wearing parts	Yes	No	No
Typical cost (\$US/Mcf/d capacity)	9,000-10,500	3,800-7,400	1,500-5,100
Typical cost (\$US/gal/day capacity)	500	250-500	100-300
Can use coal mine methane ²	Yes	Yes	Yes
Commercial availability	Now	Late 1998	1999

¹Estimated for commercial operation when available.

²Either coal mining operations or "stand-alone" wells can provide coalbed methane for the process. Utilization of the methane that coal mining operations produce is especially attractive because in most cases, the mines vent this methane to the atmosphere. This "waste gas" is a valuable fuel if mines use it; otherwise it is a potent greenhouse gas.

For More Information...

New technologies for liquifying natural gas are expanding the options for using methane recovered from coal mines. Use of LNG derived from coal mine methane can increase mine profits while reducing methane emissions to the atmosphere.

To obtain more information about technologies for liquifying coal mine methane or conventional natural gas, contact:

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Or contact EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane:

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